DUKE ENERGY SOUTH CAROLINA GRID IMPROVEMENT INITIATIVE WORKSHOP

National Context of Grid Modernization Coreina Chan, Rocky Mountain Institute

August 14, 2018



The technological and economic factors underlying today's electricity grid are changing rapidly nationwide

Old Reality

Supply

Large, centralized generation resources provide least-cost energy

Jelivery

The distribution grid is optimized for one-way flow of power, information, and value

Demand

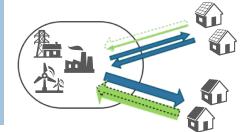
Customer load is projected to continuously grow, and considered uncontrollable

New Reality

A growing array of distributed energy resources (DERs) can provide energy and additional value to the grid



Emerging distributed generation technologies create need for two-way flows

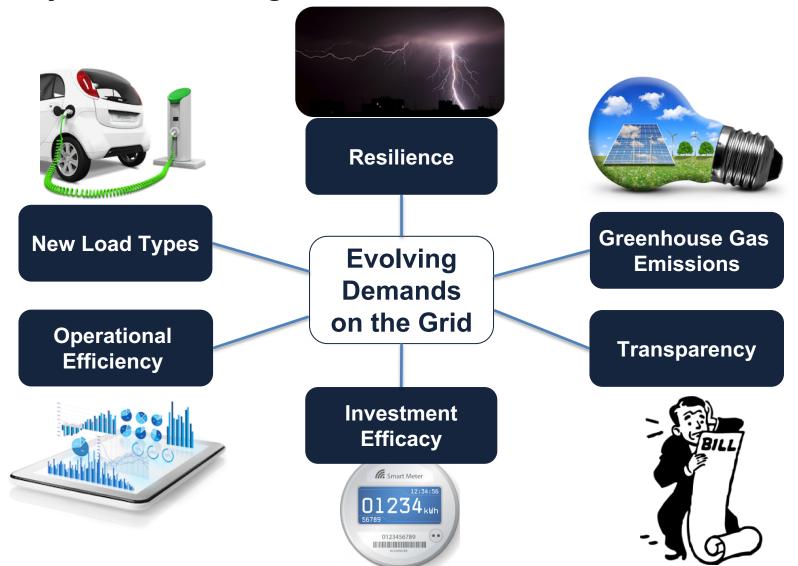


Load growth is flat, but increasingly dynamic





These changes coincide with evolving demands placed on the grid by customers, regulators, and other stakeholders



"Grid modernization" across the US is defined broadly to include a wide range of approaches to meeting these new demands

Definition elements from nationally-focused research organizations:

- "a holistic strategy" investments, business practices, regulatory reform
- "highly context dependent" depends on the system in question

Investment strategies

- Grid sensing, control, and coordination technologies
- Energy storage
- · Hosting capacity / capability
- · Hardening, resilience, security
- Customer-facing data systems

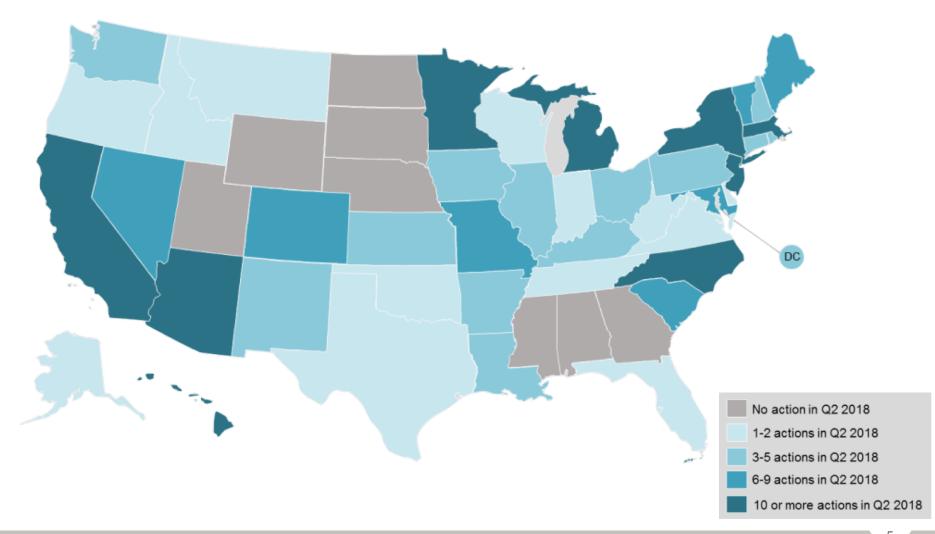
Regulatory reforms and other activities

- Rate design
- Business model updates
- Other regulatory reforms



States are proceeding at varying paces of grid modernization

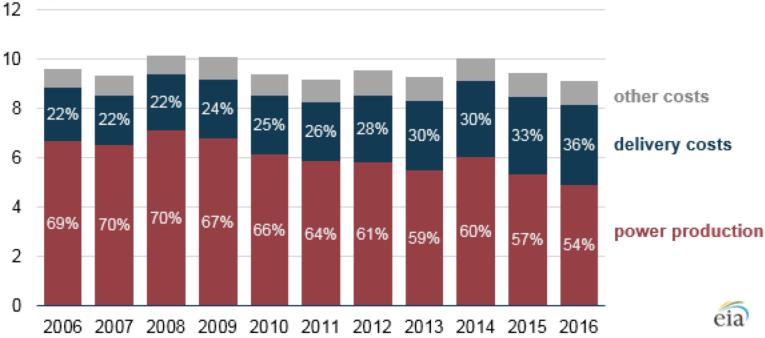
Number of grid modernization actions taken by states in Q2 2018





Investments in the grid, including grid modernization efforts, have led to increased costs for energy delivery

Federal Energy Regulatory Commission-regulated utility spending cents per kilowatthour (\$2016)



- Average retail electricity prices have stayed stable since 2006, while T&D costs have increased by >50%
- No clear data on how much has been driven by "modernization" versus either routine or cyclical spending

Grid modernization processes face common tradeoffs between competing priorities, creating an opportunity for collaboration

Differing outcomes prioritized

- Rate stability
- Reliability
- Resilience
- Economic development
- Market animation
- New technology deployment
- Environmental benefits

Common tradeoffs

- · Cost vs. benefit
- Short- vs. long-term costs and benefit
- Who pays and who benefits
- Speed versus inclusion
- "Input" versus"feedback" engagement

Collaboration opportunity

- Visibility
- Shared understanding
- Building trust between individuals and organizations
- Find multiple benefits of a shared vision







Utilities have met these growing demands through various approaches

Pacific Gas & Electric is using software to project the load impact of DER adoption at hourly intervals, down to the meter level

New Load Types

Operational Efficiency

Using automated feeder switching, PECO avoided 6,000 truck rolls and reduced service restoration times by 2-3 days after Sandy Michigan requires utilities to hold cybersecurity trainings for employees and provide notifications as soon as a cybersecurity incident is detected

Resilience

Evolving Demands on the Grid

Investment Efficacy

Xcel used analytics software to gather usage data from transmission EMS & six coal plants, saving \$46M over 6 years Arizona adopted an RPS of 15% by 2025 and proposed a Clean Peak Standard

Greenhouse Gas Emissions

Transparency

Entergy New Orleans partnered with 7 local non-profits to serve as ambassadors for reaching out to low-income customers regarding its grid mod programs



Individual state statutes and regulatory bodies have defined grid modernization in a wide variety of ways

Grid Modernization is...



"Grid modernization refers to computer-based control and automation technology to bring current utility electricity delivery systems into the 21st century."

-- Hawaii State Energy Office

- (i) "enhancing the **reliability** of the electrical grid;
- (ii) improving the **security** of the electrical grid against cyber threats and physical threats;
- (iii) increasing energy

 conservation
 opportunities by
 facilitating communication
 between the utility and its
 customers"
- -- Minnesota Statute § 116C.779(k)

- (1) "reducing the effects of outages;
- (2) optimizing demand, which includes reducing system and customer costs;
- (3) integrating distributed resources;
- (4) improving workforce and asset management."
- -- Massachusetts Dept. of Public Utilities 12-76-B



Across the US, different elements of grid modernization are prioritized depending on circumstances

Different terms of definition from nationally-focused organizations

"We define grid modernization broadly, including: new technology, infrastructure deployment; reforms to policy and regulatory structure; improved planning procedures; as well as updates to rate design and utility business models."

-- NC Clean Energy Technology Center

"Grid modernization is the overlay of **communication** and control/coordination technologies onto the **electromechanical grid**, and appropriate investments are highly context dependent."

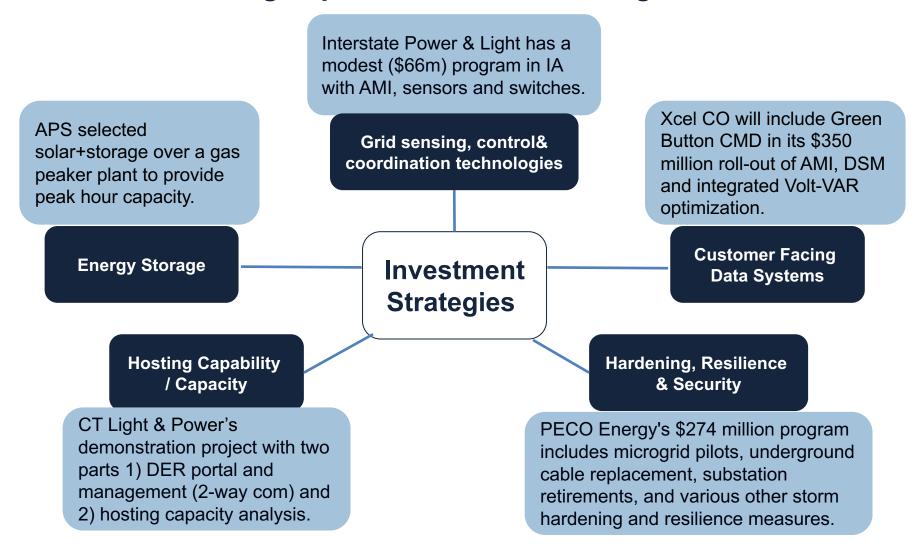
-- Pacific Northwest National Lab

Despite different definitions, there is wide agreement regarding the attributes and functionality a modernized grid should have "Grid modernization is a holistic strategy to accomplish all of the following: more efficient use of capital along with higher asset utilization; enhanced reliability, resilience and security; greater levels of energy efficiency; improved operational efficiency; and reducing GHG emissions."

-- GridWise Alliance



Grid modernization efforts are composed of a wide variety of activities, including capital investment strategies





Massachusetts: A state-led process defining grid modernization goals to guide utility investments

Overview of Process

Commission orders grid-mod investigation, soliciting stakeholder feedback through workshops



Utilities required to submit 5-year Grid Mod Plans (GMP) that outline plans & investments



Stakeholder suggestions for improvement:

- More rigorous cost-benefit analysis
- More detailed project plans
- Include distributed resources in addition to centralized grid improvements



Massachusetts: A state-led process defining grid modernization goals to guide utility investments

Grid coordination and control

AMI considered backbone of modern grid; must be implemented within 5 years

Reliability, resilience, and security

Cybersecurity issues with AMI must be addressed using best practices

Approach to Grid Modernization

Enabling DER and renewables

200 MW by 2020 storage mandate

Cost effectiveness & assessing alternatives

GMPs must include business-case analysis

Customer data and experience

GMPs must include plans for marketing, education, and outreach to better engage customers



Hawaii: Utility proposals required to address unique state renewable portfolio standards

Overview of Process

Commission orders utilities to develop comprehensive grid-mod strategy for stakeholder review



Initial utility plans were rejected due to cost concerns and insufficient integration of renewables



Final proposal approved for addressing state portfolio standards:*

- 70% renewable by 2030
- 100% renewable by 2045

Hawaii: Utility proposals required to address unique state renewable portfolio standards

Reliability, resilience, and security

Smart devices on problematic circuits & automation for improved reliability

Grid coordination and control

AMI should be deployed strategically, not system-wide

Approach to Grid Modernization

Enabling DER and renewables

Advanced inverters and meters to enable private rooftop solar

Cost effectiveness & assessing alternatives

Proposal includes four methods of costeffectiveness analysis, tailored to each asset in the integrated grid planning

Customer data and experience

Provide customers with outage notifications via social media



Maryland: Ongoing process focused on enabling DERs and expanding customer choice

Overview of Process

Commission used Exelon-Pepco merger to initiate proceeding to explore grid modernization



In parallel, commission initiated two proceedings to explore how customers can consume and produce electricity differently



Commission convened public conference to solicit input from stakeholders



Stakeholders included IPPs, utilities, consumer organizations, ISOs and grid-facing organizations



Maryland: Ongoing process focused on enabling DERs and expanding customer choice

Reliability, resilience, and security

T&D hardening: upgrade substations and install 10 mi of underground transmission cables

Grid coordination and control

Develop a statewide standard for AMI

Approach to Grid Modernization

Enabling DER and renewables

Develop strategy for widespread vehicle fleet electrification while mitigating grid-related costs

Cost effectiveness & assessing alternatives

Undergoing targeted review of state distribution system

Customer data and experience

Change retail choice to make it more competitive and transparent

